# AN EXPERIMENT TO MEASURE THE TRANSVERSE ELECTRIC COMPONENT OF ATMOSPHERIC RADIO NOISE

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## LONG-TERM GOAL

Our goal was to measure the strength of the horizontal electric component of atmospheric radio noise and examine its statistical variation. These data would support assessment of strategic communications at very low frequencies (20 to 30 kHz) for airborne platforms, in particular the Navy's TACAMO and the Air Force's long-range bombers.

## SCIENTIFIC OBJECTIVES

Our objective was to evaluate models of atmospheric radio noise at very low frequencies (10 to 30 kHz), particularly predictions for the horizontal component of the electric field of the radio noise.

## APPROACH

Our approach was to deploy antennae on the Greenland Ice Cap to take advantage of the 3000 meter thick dielectric and the accompanying reduction of field-canceling induced horizontal currents. We sought to obtain data over most of a year to enable development of statistical information about the horizontal component of the electric field of the radio noise.

## WORK COMPLETED

In the summer of 1993, we tested the approach by deploying equipment during a 5 week field season. The experience verified the approach and plans were made to deploy equipment to operate over the course of the winter to avoid the man-made interference of an operating field camp, with its primary interference being the diesel electric generators. We deployed battery operated equipment at the middle of the Greenland Ice Cap in June of 1995. The existing scientific camp had a large bank of batteries of varying sizes and configurations already installed. We also installed a wind turbine at Summit to provide charging for these batteries, supplementing a panel of solar cells. A key element of our equipment suite was a large horizontal loop for detecting the vertical component of the magnetic component of the radio noise. Our equipment was set to operate over the winter of 1995. We returned to Summit in 1996 to retrieve the data and to prepare the equipment for a second, and final, winter of data collection. Due to a failure of one of the large house batteries in the battery bank we obtained very little useful data over the winter of 1995. However, another experiment was installed at the camp using a bank of new batteries. We arranged to share this bank and left the equipment to operate over the winter of 1996. We returned in May of 1997 to collect the data and to retrieve the equipment. Unfortunately, we had another failure of the power system and obtained very little useful data. We have subsequently learned that the other experiment using the battery bank obtained but a single byte of data. Apparently the power failure happened very early in the data collection

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period. The available data were processed in the last quarter of the fiscal year and a final report prepared.

## RESULTS

During the initial field season in 1993 we collected samples of data from the Navy's fixed broadcast stations and at selected noise frequencies. A sample of data from Cutler at 24 kHz is shown in Figure 1. The field strengths have been scaled according to calibrations made in the field. Both the TM and TE signals show a slight diurnal variation with a maximum near local midnight (0300 UT) and a minimum near local noon (1500 UT). The signals show slightly more variability during the night than during the day. Calculations using our propagation model show that the signal from Cutler was expected to be about 44 dB for the TM and about 27 dB for the TE at local noon. We see that the measured TM signal was about 48 dB ±3 dB and the measured TE signal was about 31 dB ±2 dB. Thus, the calculations are higher than the middle of the observations by 6 dB and 4 dB, respectively. The corresponding values for local midnight are 49 dB and 27 dB (calculated) and 50 dB ±5 dB and 27 dB ±3 dB (observed). These results clearly show that the concept of improving the TE/TM ratio by making measurements on the Ice Cap is valid.

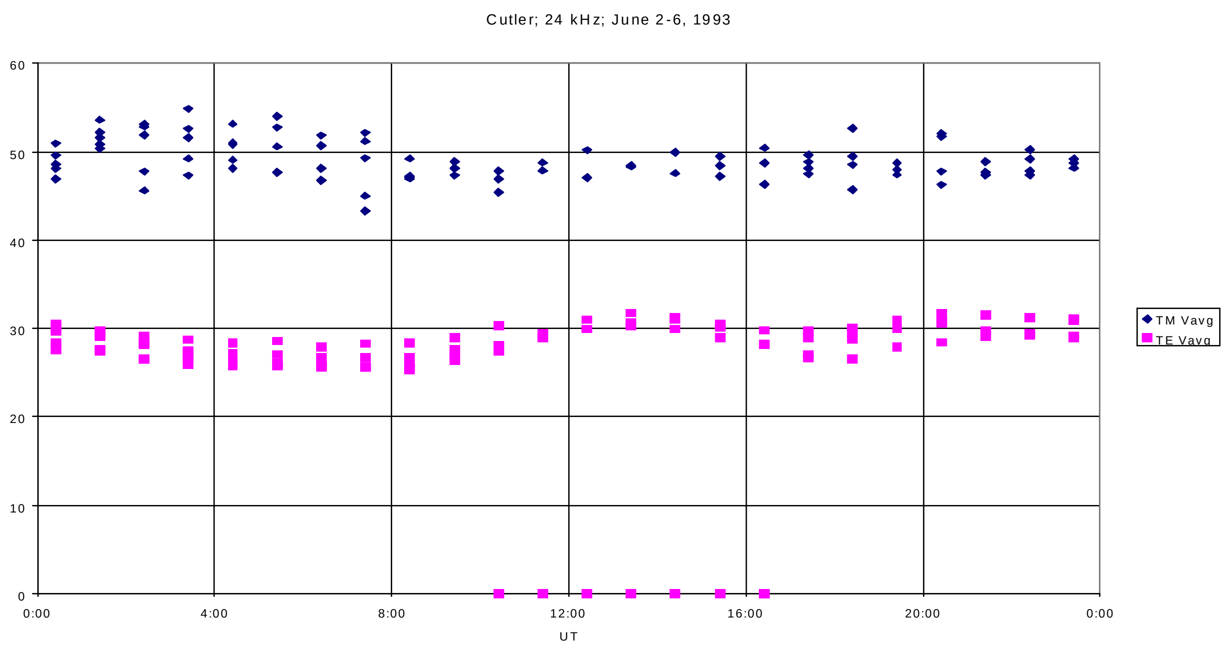


Figure 1. Cutler Signals at Summit; June 2-6, 1993

Noise data were collected simultaneously with the data for Cutler. A sample of the data collected at 9 kHz is shown in Figure 2. It should be noted that the data were scaled by adding an arbitrary value to the values in dB/V to convert them to dB/μV/m. The factor was chosen to be close to the values determined from the calibration at 24 kHz. There is very little variation of the average noise during the course of the day, which is to be expected because Summit is entirely in daylight in the summer. There is quite a bit of scatter in the afternoon and may indicate man-made interference. However, the fact that the TE signal does not track perfectly with the TM signal

strongly suggests that the signals are not coupled due to TM contamination of the TE loop. Calculations of the noise using the Longwave Noise Program (LNP) at 9 kHz are shown in Figure 3. There is some agreement between the observations and the calculations. A brief sample of the data for 34 kHz are shown in Figure 4. The diurnal pattern seen in the noise data is similar to that from Cutler although there was a lot more scattered about the average. Calculations of the noise using the LNP at 34 kHz are shown in Figure 5. There is not much agreement between the observations and the model predictions in either the diurnal behavior or the overall amplitudes. However, the diurnal pattern shown by the LNP is unusual. This was not cause for great concern at this point because part of the purpose of the experiment was to collect data to validate the model.

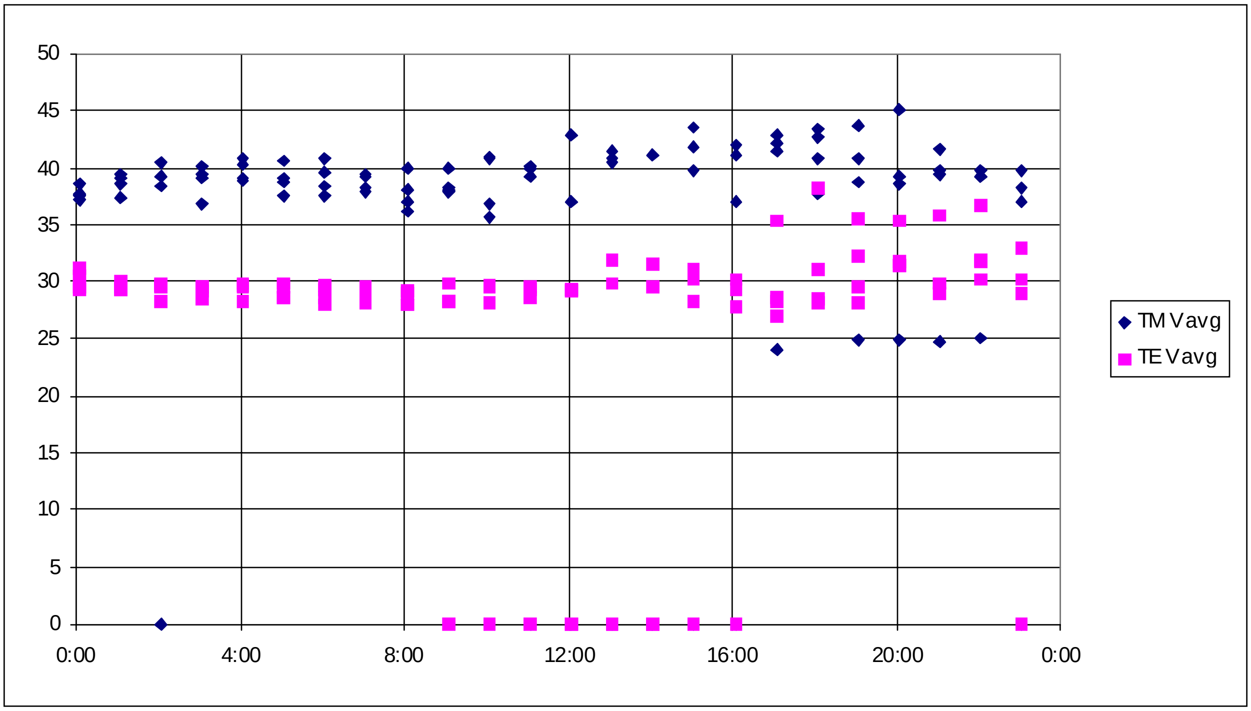


Figure 2. Noise at 9 kHz at Summit; June 2-6, 1993

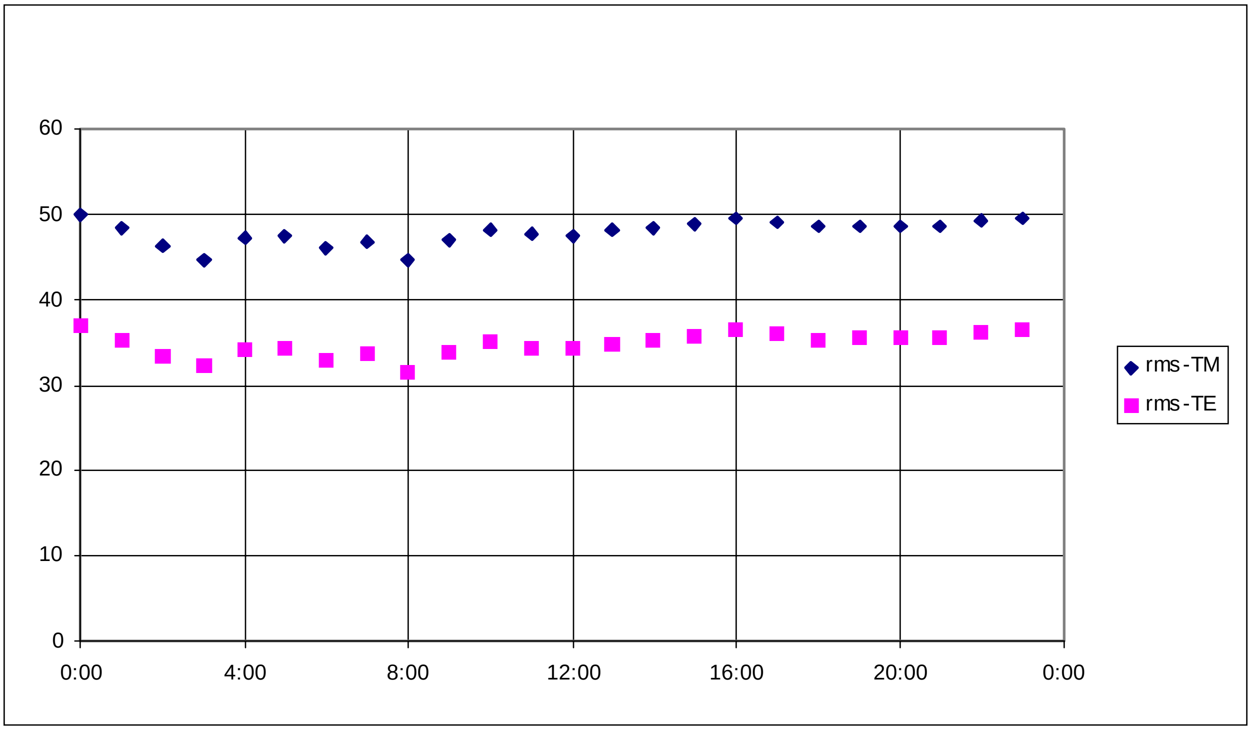


Figure 3. Noise at 9 kHz at Summit Calculated by LNP

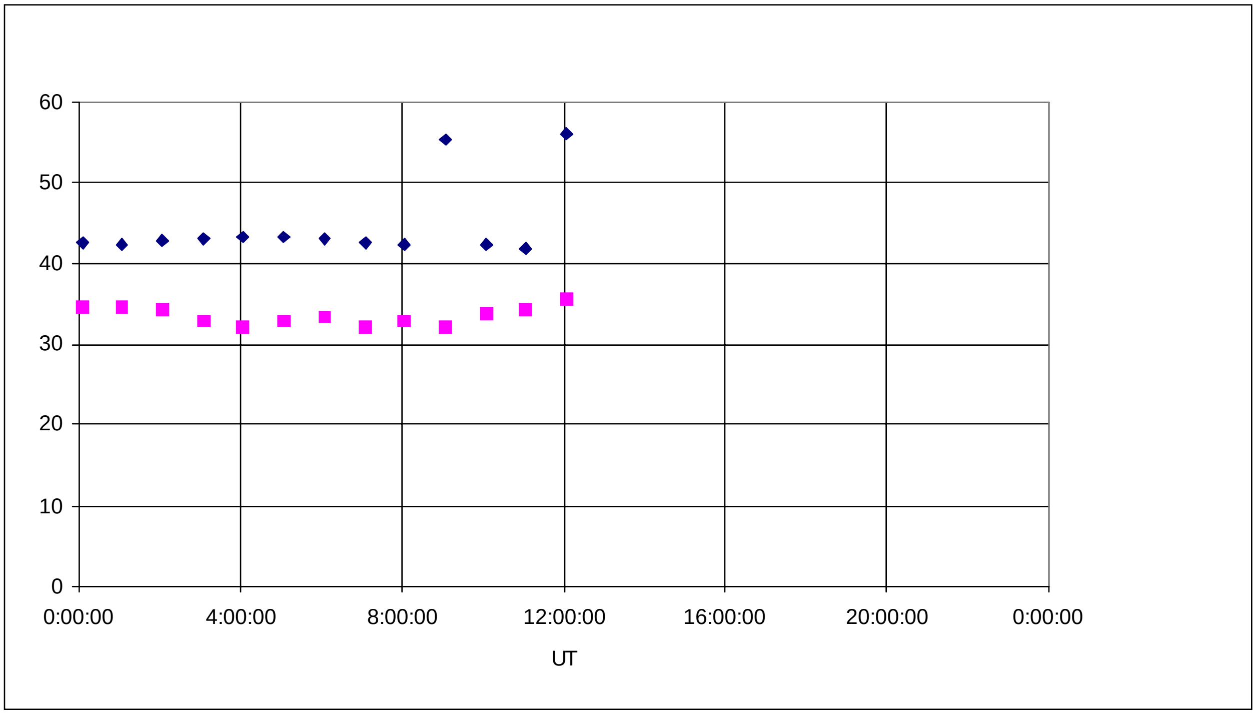


Figure 4. Noise at 34 kHz at Summit; June 6, 1993

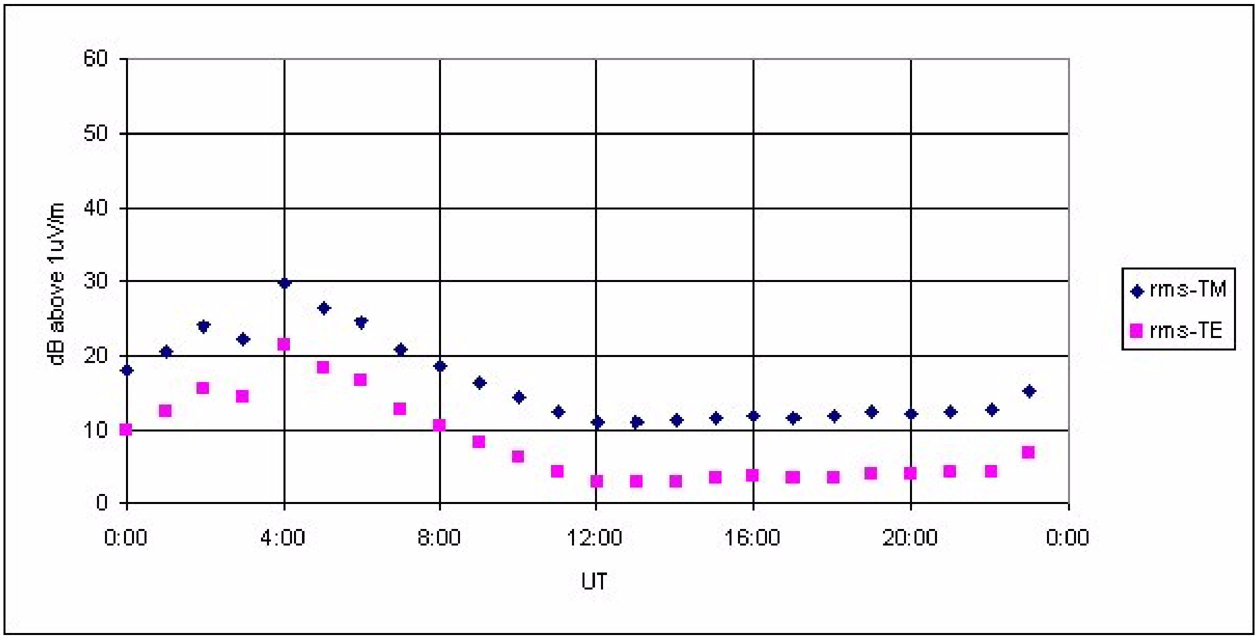


Figure 5. Noise at 34 kHz at Summit Calculated by LNP

In spite of the problems encountered during this experiment, it can still be completed. The scientific achievement was not fully realized but the approach and the possible results were demonstrated. A properly prepared suite of equipment with its own source of power could easily achieve the original objective of collecting significant amounts of the horizontal electric component of atmospheric noise data.

## IMPACT/APPLICATION

The results of these measurements would have been a unique data base of the strength and variation of the horizontal electric component of atmospheric radio noise. In addition, these data would have been used to assess current models of atmospheric radio noise, particularly the ONR-funded Longwave Noise Program.

## TRANSITIONS

This experiment was to provide data to be used by developers of models of atmospheric noise. Currently, such models are supported by the Office of Naval Research and the Defense Nuclear Agency.

## RELATED PROJECTS

There is no other work of this kind being performed. However, the data to be collected would be used to assess and improve models of atmospheric noise, in particular the Longwave Noise Program sponsored by the ONR.

## REFERENCES

Insufficient data preclude publication.